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ABSTRACT

Reported are the results of a study involving 1800 3-year-old children which was conducted to investigate in detail children who might appear to be at risk for later psychiatric breakdown. Described are study procedures including collection of background data on each child through visits with the parents, observation of children's play behavior and intellectual performance in the laboratory, and administration of pediatric and psychophysiological tests. The rationale for using an auditory tape procedure for elicitation of responses is explained. Also discussed are preliminary results and some procedural considerations (such as the role of nursery schools in the project). Among findings reported are that it appears to be possible to select, by psychophysiological techniques at the age of 3, children who behave differently at the age of 6 and who react differently to the intervening experience of attendance at a nursery school; and that the type of behavior exhibited by the children is not in discord with what might legitimately be expected on the basis of earlier high risk studies and data from work on adult patients. Also included are tables with statistical data, a list of references, and graphs illustrating study results. (SBH)

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# SCREENING FOR RISK OF MENTAL ILLNESS

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## 1. INTRODUCTION

The work to be reported in this paper concerns an attempt which has been made, on the Island of Mauritius, to screen a complete population of children of one age range in two large towns with the aim of studying in detail those who might appear to be at risk for later psychiatric breakdown. This study follows directly from those which have been previously carried out using the "high risk" model (Mednick and McNeil, 1968), and described in this symposium in a paper by Mednick, but differs from them in two important ways, namely that risk is determined solely on the basis of psychophysiological indices and the study is carried out in a developing country.

Garmezy (1974) and Jones (1973) have reviewed research aimed at studying the development of schizophrenia using prospective or high risk methods. In general, their studies employ the technique of examining subjects in a pre-morbid state who may have a higher than normal probability of breakdown. In most cases this higher than normal probability of becoming ill is determined by the selection of subjects who have an increased genetic loading for the disease because they are children of parents, one or both of whom are schizophrenic. The use of such high risk samples is a tactic which greatly increases the probability that the sample studied will eventually contain subjects who will suffer psychiatric breakdown. However, with the generally reported morbid risk for schizophrenia of around 1% in the general population, a study which relies on the testing of an unselected population with the hope of discovering those who will later succumb with schizophrenia is clearly uneconomic.

The issue of selecting the most appropriate children for investigation becomes particularly important if a decision is made to start the study early in the child's life in order that, firstly, a longer time scale may be allowed in which to examine precipitating factors and, secondly, the possibility of undertaking interventive techniques to lessen the chances of the development of the disease may be contemplated.

The study to be described differs from those previously undertaken in that not only does it start with children at the early age of three years, but it also starts with the selection of a sample of a total population, not on the basis of the states of the parents, but on the psychophysiological characteristics of the children themselves.

The study is also unique in that it is probably the first to be carried out in a "developing" country. The origin of this study may be seen in the WHO Technical Report No 381 (1968) in which, following a meeting in 1967 of the Scientific Group on Neurophysiological Research, it was recommended that very high priority be given to

> "(a) the study of critical periods of development, to examine the effect of environmental factors on subsequent mental health; and
>
> (b) longitudinal neurophysiological studies of high risk subjects".

It was also suggested that "developing countries ... may be considered as locations". India was originally suggested but following assessment of the facilities for such work offered in Mauritius, a decision was taken by Schulsinger and Mednick of the Psykologisk Institut,

Copenhagen and Raman in Mauritius to attempt to mount a study there.

The decision to base this study on children selected from the general population rather than from a genetically defined group was in part made because it was thought that it would be difficult to define a group of schizophrenic index cases from which to start the study in a situation where there was only one mental hospital and it was likely that a large proportion of schizophrenics might not be hospitalized. Selection of subjects from a total population also provided an opportunity to try out an alternative procedure for undertaking high risk work, to those which had been adopted so far. It was decided that the method of screening which would be adopted would be to employ psychophysiological techniques which had been successful in Copenhagen (e.g. Mednick and Schulsinger, 1968) in predicting those children who later suffered psychiatric breakdown. Although in their original 1962 study (which was reported, for example, in 1968) Mednick and Schulsinger had employed measures of electrodermal, cardiovascular, respiratory and electromyographic activity, the major proportion of their work was based on the use of electrodermal measures with a small amount being carried out using heart rate measurement and no attention being paid to the other variables. It was found that measures of electrodermal activity were particularly important in being related to later breakdown and had better predictive value than other measures including psychological and psychiatric indices assessed concurrently.

The decision to adopt psychophysiological measures for screening purposes does, however, present very much of a step in the dark and the choice of only electrodermal variables for selection purposes makes

the study even more open to criticism. Garmezy (1974),in a discussion of the project, states "I believe that their attempt to lean on deviant psychophysiological response systems is not only premature but inappropriate when applied to 3-4 year olds"; he might have added, especially when the study is carried out on a tropical island on racial groups about which available psychophysiological data is virtually non-existent.

This report, therefore, seeks to establish that the exercise to date appears to have been worthwhile. It cannot, of course, do more than this because for eventual validation of the technique used it is necessary to wait for twenty or so years in order that the subjects studied may enter the risk period for breakdown.

The attempt at validation of the selective procedure is a tripartite one. The variables used in selection of subjects for further study were a sub-sample of those actually measured. Using these variables four groups of subjects were selected; three being potentially abnormal and one control. The first form of validation procedure was to use discriminant function technique employing the so far unused variables to see how far the empirically defined risk groups might be successfully predicted using these unused variables. Secondly, after the selection procedures were completed in 1973, data from other studies became available which provided excellent evidence for differences between genetically selected high and low risk groups on variables which had been measured in Mauritius but which had not been used in selection. The availability of this material provided a basis for external validation of the screening procedures. Finally, it was thought to be desirable to show that,as a result of screening, groups

of children had been selected who might behave differently on a subsequent occasion. The last study to be described therefore outlines work carried out three years after the original screening which indicates that the groups selected as having members who might become abnormal behaved in a different manner from the selected controls as a result of exposure to nursery school experiences.

## II. METHOD AND PROCEDURE

Mauritius is an island with about 900,000 inhabitants occupying an area of approximately 2,400 square kilometres. The population is a mixed one being approximately two thirds of Indian origin and having as its next largest racial group the "general population" or Creoles having an African origin with admixture of the island's other racial groups.

It was decided to carry out the research in two large towns in the central, fairly densely populated part of the island, which had a racial distribution within their populations which fairly represented the proportions of racial groups found in the island as a whole.

Lists of 3 year old children were prepared from the Ministry of Health Vaccination Register and parents were contacted by a field worker who encouraged them to allow their children to attend a laboratory in Quatre Bornes - one of the two towns whose population was being studied. The children were transported to the laboratory from this and the other town, Vacaos, accompanied usually by parents but on occasion by grandparents.

The initial visit to the parents by the field worker enabled a substantial amount of background data to be collected and this was supplemented by further items when the parents came to the laboratory. At the laboratory the children's behaviour was observed in a standard play situation and their intellectual performance was measured by tests adapted from Western versions for use on the island. This work was carried out under the direction of Dr Brian Sutton-Smith, of Teachers College, Columbia University, New York. The children were also given a paediatric examination by local doctors and, if necessary, were referred after this examination to local clinics or hospitals.

The children also undertook a session of psychophysiological measurement, the results of which are the main content of this paper. Up to ten children were tested each day, five in the morning and five in the afternoon. The children were randomly allocated to the order in which they would undertake psychological and psychophysiological testing.

In all, 1800 children were tested, of whom complete psychophysiological data are available on 1795. The racial and sex distribution of the sample of 1800 is shown in Table 1 and the racial distribution is compared with that for the whole island shown in recent statistical reports. It can be seen that the sample is a close match in this respect to the island's population.

The psychophysiological indices measured were skin conductance, skin potential and EKG. Skin conductance was measured from the medial phalanges of the middle and ring finger of the left hand using the constant voltage circuitry outlined in Venables and Christie (1973) and using Beckman miniature silver - silver chloride electrodes with

0.5% KCL in 2.0% agar-agar as the electrolyte. Similar electrodes were also placed on the right hand and measures of skin conductance level obtained at the start and finish of the experiment by switching electrode pairs to the single skin conductance channel.

Miniature Beckman electrodes placed on the hypothenar eminence of the left hand and the inner surface of the left forearm were used to measure skin potential.

EKG was measured by similar electrodes using standard lead I.

Recordings were made using a Grass Type 79 Polygraph using 7P1 pre-amplifiers for skin conductance and skin potential and a 7P5 pre-amplifier for EKG measurement.

Four characteristics associated with each skin conductance response were recorded. These are:

1. Skin conductance level at the start of the response;
2. Amplitude of skin conductance responses;
3. Latency of response;
4. Time taken for the response to return to half its peak amplitude - "half recovery time".

These characteristics are shown in Figure 1. Also measured were the number of spontaneous, unelicited responses occurring in a minute's recording at the start and a one minute period at the end of the recording session, together with the skin conductance level shown by both left and right hands at this time.

Skin potential and EKG data will not be dealt with in detail in this report.

Auditory stimuli for the elicitation of autonomic responses were presented by the use of an auditory tape via a Tandberg tape recorder and Sennheiser headphones. The characteristics of the stimuli used are discussed in the next section.

The children sat on the parent's lap during testing; it was established that the parent could not hear the stimuli presented through the headphones to the child. The child was thus not reacting in a secondary fashion to stimuli heard by the parent. It was found in pilot studies that the children were much less disturbed and testing was more easily carried out in this manner than when they were tested in isolation. The whole psychophysiological testing period, including fixing electrodes and their later removal took approximately half an hour.

The polygraph records were scored and responses coded and entered on computer coding sheets in Mauritius; these coding sheets were then sent to the U.K. for subsequent analysis.

The testing procedure was carried out in a sound insulated, temperature controlled cubicle adjacent to the polygraph. A de-humidifier was used to minimize the variation in humidity although the level of humidity could not be said to be controlled. The psychophysiological testing situation thus compared favourably with those to be found in developing countries.

## III. RATIONALE FOR PROCEDURES USED

As stated earlier in the paper, this study is a logical extension of the work carried out in Copenhagen and consequently the methods used are derived from this earlier experience.

At the time of setting up the Mauritius work prior to its commencement in 1972 the data available from the Copenhagen study were essentially those published by Mednick and Schulsinger in 1968. An auditory tape procedure was used in this work for the elicitation of responses. The construction of this tape was in three sections and conceived around the idea of testing the subject's electrodermal conditionability. The sections were (a) the presentation of the stimulus to be used as the conditioned stimulus in an orientation or "desensitization" session, (b) the presentation of CS and UCS in a conditioning paradigm and (c) an extinction and generalization period in which the CS and generalization tones were presented unpaired with the UCS. The 1968 analysis of the data suggested that subjects who later became ill differed from those who did not in several ways when tested in 1962. These were, for instance, in the amplitude of the skin resistance response (SRR,GSR) to the UCS, in test trials where the UCS was omitted and in generalization trials. The other important finding was that the recovery of the SRR from peak amplitude was faster in the case of the children who later broke down than in those who did not.

It thus seemed important to capitalize on these findings in the design of the procedure in Mauritius. Modifications from the original 1962 procedure were made in several directions. Firstly, in order to examine a large number of subjects and essentially to design a screening rather than an experimental procedure, the time of testing had to be

considerably reduced. Secondly, work on GSR conditioning conducted since 1962 suggested modifications of the conditioning procedure so that, for instance, a longer CS-UCS interval was employed and, thirdly, work carried out by the author and his colleague, John Gruzelier, summarized in Venables (1975) had shown the value of using an orienting and habituation procedure in work with adult schizophrenics. This work suggested that there were, under suitable testing conditions, two types of responsivity shown by schizophrenic patients, namely, hyper-responsivity - that is, many high amplitude short recovery skin conductance responses (SCRs), a pattern, in fact, similar to that shown by the Copenhagen children who later became ill - and hypo-responsivity - that is, minimal or no responsivity.

This work suggested that it was worthwhile incorporating in a test procedure a close approximation to the orienting situation which had produced these results.

Table 2 shows the details of the auditory stimulus tape which was used. Stimuli 1-3 are 1000 Hz, 75 db, 1 sec tones having 25 msec rise and fall times. The characteristics of these stimuli are those used by Vanables and Gruzelier, and the use of a non-abrupt stimulus onset with 75 db intensity ensures that orienting rather than defensive responses would be elicited. Stimuli 4-6 are similar tones but with a change of frequency to 1311 Hz. It was intended that by the use of these first six tones, orientation to tone onset and to change of tone and habituation might be examined. The next twelve stimuli consist essentially of a delayed conditioning procedure using a 12.5 sec, 1000 Hz, 60 db, 25 msec rise time positive CS, followed after 10 sec and overlapping with for 2.5 sec, by a 4.5 sec, 90 db UCS which

consisted of a mixture of white noise and noises recorded from a buzzer in a resonant chamber. Although not of excessive intensity, the noise was of particularly unpleasant quality. Stimuli of this kind were numbered 7, 8, 11, 12, 15 and 17. Interspersed between these were unreinforced positive CS stimuli (as a form of test for conditioning) and unreinforced negative CS stimuli of 500 Hz frequency. Stimuli 18-24 are all unreinforced and consist of extinction trials. While such a short conditioning procedure was unlikely to be very effective with the majority of subjects it was hoped that the hypothesized high rate of conditionability which might be shown by the hyper-responsive, high risk subjects would be shown by this procedure. The use of a delayed conditioning procedure allows the measurement of three responses, that to the CS onset, that to the UCS onset and the anticipatory or pre-UCS response, this last being suggested on the 'true' conditioned response (see, for instance, the review by Dengerink and Taylor, 1971). The procedure thus allows two types of test for conditioning by the use of omitted stimuli after CS+ and by the ability to measure pre-UCS responses. In the remainder of this presentation the three responses are designated as follows - to the CS, the A response, pre-UCS, the B response, to the UCS, the C response. The definition of the responses for measurement purposes was by latency criteria. The "latency windows" used and the timing of the stimuli are shown in Figure 2.

The auditory stimuli were recorded on one channel of a stereo tape recorder. The other channel contained 400 Hz 1 sec pulses synchronized with the onset of auditory stimuli, which served, via appropriate circuitry, to operate a marker pen on the polygraph.

## IV. PRELIMINARY RESULTS

Of the 1800 subjects tested 1795 provided usable electrodermal records.

Five environmental measures were available; these were laboratory temperature and humidity and external ambient temperature, humidity and barometric pressure.

These five measures were correlated with the electrodermal measures described for responses to all stimuli, in addition to measures of initial and final conductance level. In no case was there any correlation between electrodermal and environmental variables accounting for more than 1% of the variance. Thus one of the major worries that the work in this unfamiliar environment might be complicated by unusual environmental variables proved to be unwarranted. It is likely that the effects of temperature and humidity were minimized because of the degree of control which was established in the laboratory. Whereas the external temperature had a mean value of 22.98°C with an SD of 3.14°C, in the laboratory the mean temperature was 30.0°C SD 1.45°C. The mean external relative humidity was 76.96% SD 11.99% and in the laboratory 51.85% SD 4.22%.

The distribution of electrodermal measures was examined; it was found that both SCL and SCR measures showed some skew, but log conversion produced distributions with insignificant skew. It should be noticed that in the case of the response measures, log conductance change but not change in log conductance was normally distributed. Data in this paper are reported in terms of conductance measures for the sake of familiarity even when the statistics have been carried out using log

values. Thus it is possibled to be reassured that the measures taken in the study can be used satisfactorily and that there is nothing to suggest that the somewhat unusual situation in which the work was carried out produced abnormal results.

## V. SOME PROCEDURAL CONSIDERATIONS

### The role of Nursery Schools in the Project

In this project it was decided to set up nursery school facilities for two purposes. One was that they provided a suitable setting for the observation of the children which was under the control of the investigators. The second was that,although no very defined program of intervention could be laid down at this point, with the use of suitable control groups, the role of a nursery school milieu in the modification of behaviour could be examined.

The possibility of the use of preventive techniques with very young children, even if the degree of risk of eventual psychiatric breakdown could be accurately determined is clearly fraught with difficulties. A WHO meeting on "Primary prevention of schizophrenia in High Risk groups" held in Copenhagen in 1975 - and hence some time after the inception of the Mauritius project - stated that with one exception "there are no data from controlled intervention studies that would provide an indication of which interventions, if any, are helpful either to the children at risk or their parents". For instance, "psychopharmacological intervention with subjects at risk but not ill was specifically disavowed in this connexion". The use of a nursery

school thus represented a minimal and entirely ethically acceptable form of intervention.

A "spin-off" from the exercise was that of starting the first nursery schools in Mauritius, a project since taken up and given support by the Mauritian government. Two nursery schools were set up with finance from DANIDA, a branch of the Danish Government having the role of assisting developing countries. In addition to providing funds for the material provision of the schools, the fund also paid for the services of two Danish kindergarten experts, Steen Møller and Bodil Birket-Smith who were responsible for the running of the schools and the training of the first 14 nursery school teachers in Mauritius.

Electrodermal activity as a selection procedure

Immediately on completion of the testing procedure the electrodermal data were coded and used to select 200 subjects for later extended study. In this instance, none of the checks on distribution and environmental variables could be carried out because of the necessity for speedy allocation of the children to the nursery schools which were waiting for their intake. It should, however, be said at this point that subsequent careful checking of the selection procedure, taking account of all appropriate variables has shown that there were no faults in the original procedure.

The aim of the selection procedure was to obtain four reasonably matched groups of subjects. Two of these were to be allocated to the two nursery schools, one in Vacaos and one in Quatre Bornes, and two, drawn from each of these communities, were to remain unallocated to

nursery schools.

Three types of variables only entered into the selection procedure. These were, in addition to the electrodermal variables, those of sex and race. The aim was to achieve groups having a more or less equal sex distribution and having approximately the same racial distribution as the 1800 subjects shown in Table 1. It was decided not to include Chinese children as there would only be one in each nursery school and they might be isolated on this account. The final distribution of children by sex and race is shown in Table 3.

The initial procedure was the development of electrodermal risk criteria and the allocation of children to groups using these criteria. From these, and taking account of sex and race variables, four groups of subjects were drawn up in the U.K. and cabled to Mauritius. The staff in Mauritius then invited those allocated to the nursery schools to attend.

If the parents of a selected child were unwilling for him or her to attend, a cable was sent to the U.K. asking for the name of a substitute child. This procedure continued for about 6 weeks until all 100 children allocated to the nursery schools were established as willing to attend and it was determined that the 100 subjects selected as community controls were available and willing to attend the laboratory on subsequent occasions for testing.

Four types of subjects were selected on the basis of electrodermal variables.

The first to be selected were non-responders. Subjects in this group

showed no electrodermal responses whatsoever, either on skin conductance or skin potential channels of measurement. Both types of electrodermal measurement were included for this purpose because the chance of non-responding being a result of low skin temperature is less with skin potential than with skin conductance measurement. There is thus a substantial reason to believe that the subjects allocated to this category on the dual criterion basis were non-responders of the type carefully delineated by Gruzelier and Venables (1972).

The remainder of the subjects were selected on the basis of the SCR amplitudes and recovery times of responses to selected stimuli. The basis for this selection was as follows:-

Response 1: in that it was likely that the greatest number of subjects would respond to the first orienting stimulus and that the number would fall off with later orienting stimuli.

Response 7C: this was the response to the first presentation of the most intense stimuli in the series, the UCS, and hence most likely to provide a large number of responses.

Response 8A: this is the response to the conditioned stimulus immediately after the first presented UCS. Hence, those subjects most likely to be disturbed by the UCS might be likely to respond in this instance whereas the more "normal" subjects might not respond.

Responses 18A, 19A and 20A are all orientation responses late in the total series and should be those exhibited by subjects who do not habituate and hence are akin to the "responder" schizophrenics of Gruzelier and Venables (1972).

Responses 18B & C, 19B & C and 20B & C are all likely to be emitted by subjects who condition readily and consequently would be akin to

those who exhibited this sort of behaviour in the Copenhagen situation and who later became sick.

In summary, therefore, amplitude and half-recovery times of skin conductance responses 1, 7C, 8A, 18A, 18B, 18C, 19A, 19B, 19C, 20A, 20B and 20C were those used to establish criteria.

1. Responses were categorized as high risk for schizophrenia when they had amplitudes greater than 1 micromho and less than 2.5 secs half recovery time.

2. Responses were categorized as typical of control subjects when they had amplitudes between 0.4 and 0.9 micromho and half recovery times between 2.5 and 9.0 seconds.

3. Responses were categorized as high risk for criminality-psychopathy when they had amplitudes between 0.4 and 0.9 micromho and half recovery times greater than 9.0 seconds.

(Note all conductance values are in terms of specific conductance, i.e. micromhos/$cm^2$.)

A possible score of 1[illegible], i.e. all responses having the required characteristic, was possible.

Hyper-responsive - high risk for schizophrenia - subjects were those who had 6 or more responses with category 1 characteristics; that is, they had response patterns similar to those subjects who later suffered psychiatric breakdown in the Copenhagen series.

Allocation to control status was made on the basis of occupation of a narrow central position on the responsivity and recovery continuum of electrodermal activity and used a count of 2 or more responses in

category 2 as its criterion.

It was found, in the course of allocation of children to groups, that a sex and race match across schools and comparative community groups could not be made on the basis of allocation to only non-responder, hyper-responding (short recovery) and control groups. For this reason a fourth group was established. These were subjects showing 2 or more responses in category 3, i.e. having long recovery of the skin conductance response. The basis for this is work reported by Mednick from Copenhagen, by Hare from Canada, by Siddle et al from the U.K. and by Hinton, also from the U.K. The populations in which long skin conductance recovery time is predictive range from children whose parents are criminals, diagnosed psychopaths, borstal boys and inmates of maximum security institutions for the "criminally insane". The inclusion of this group of children is thus partly from necessity and partly because they represent another aspect of interest of the members of the investigating team.

The number of subjects in each of the categories out of the total population of 1800 are shown in Table 4.

It is clear from the percentages shown in this table that a wide net has been used for the "abnormal" groups, N, S and L, and a narrow net for the control subjects,C.

It is a presumption that among the 287 subjects in groups N, S and L there will be those who will eventually manifest deviant behaviour. This total of 15.9% of the total population is not perhaps too large if a "spectrum" rather than a narrow criterion of deviance is taken.

Table 5 shows the number of subjects in these groups allocated to nursery school and community groups. On the basis of a 1% risk for schizophrenia it is possible that 18 of the 1800 subjects tested will become schizophrenic. If there is only a 50 % success rate in selecting these subjects then 9 should appear among the N and S groups which have been selected, i.e. 136 subjects. The procedure at a conservative estimate will thus have increased the chances of selecting the appropriate children for following up by sixfold. If, of course, the procedure has been entirely successful, then the eventual result of the procedure will have been to approach the sort of chance of eventually finding patients that have been seen in genetically based high risk studies.

In no instance has the identification of subjects in risk categories ever been transmitted to Mauritius. Thus those members of staff working with the subjects in Mauritius are entirely "blind" to the status of the children. While, in general, they know the purpose of the study they have been instructed to treat all children alike and it is a reasonable assumption that they have done so as there is nothing to the casual observer which would suggest abnormality among the children.

## VI, RESULTS

### An approach to internal validation of selection procedure

As suggested in the introduction one of the problems of conducting a longitudinal study of the development of schizophrenia employing a

relatively untried selection procedure is that true validation can only be undertaken when the predicted behaviour is likely to appear, i.e. from young childhood onwards. In this case, where the initial selection has taken place when the subjects are three years old, the delay of twenty years for the final results is discouraging and steps need to be taken to reassure the investigators (and those supporting them with grant aid) that the exercise as a whole is useful and worthy of continued expenditure of effort. Because of this, attempts have been made at validation of the selection procedure. These in themselves, it should be emphasised, are not true validation but rather need to be taken to show that the procedure has a degree of consistency and is having a measurable effect.

The first and probably the weakest approach is an attempt to show that the psychophysiologically defined risk groups selected on a comparatively small number of variables may also be predicted by taking into account the other variables which were measured but not used as criteria for selection.

To this end discriminant analyses have been performed using the division of the population shown in Table 4 as the criterion groups and characteristics of electrodermal activity other than for those responses used as criterion measures as predictions of the criterion groups. Clearly, as there are correlations between the prediction variables and those used in criterion group selection, this approach is not strong. Nevertheless, the fact that over a series of discriminant analyses, of which one only is reproduced here, a useful degree of consistency of data emerged, suggests both that identifiable groups could be selected from the total population and that these could be

predicted by other than the variables actually used in selection. Because of the major reliance of the selection procedure in its derivation from the Copenhagen material, and from work with adult schizophrenics on skin conductance recovery measures, recovery data were not allowed to enter the discriminant analysis. Data was used from those amplitude data not used in selection; additional materials were the initial level of skin conductance from the right and left hands, the number of initial spontaneous responses, the mean latency of skin conductance response to the UCS, the mean latency of the skin conductance response to conditioned stimuli and the initial resting heart rate. Using these variables 72.73% of the originally selected groups were correctly identified.

Due to the self imposed restriction in the use of variables the exercise can be considered as one of "pulling oneself up by one's bootstraps with one's hands tied behind one's back". However, examination of Table 6 in which the predicted groups and selected group membership is compared is encouraging. The greatest degree of misclassification occurs between groups C and L; however, this is not surprising when they are both selected on the same amplitude criteria and recovery data is not used.

This exercise has been presented here as an example of one approach which may be taken to the problem of dealing with data under conditions where true validation is not possible. It suggests consistency in the data used for selection but is only part of a converging operation to be viewed in the context of the other material to be presented.

## An approach to external validation of the selection procedure

As stated in the last section, a number of variables were measured which were not used as criteria for the selection of the risk groups. It was thus important to find that some of these variables had been used in similar situations in genetically based high risk studies and had shown differences between high and low risk subjects.

Such a study was described at a recent meeting (1976) of the Society for Psychophysiological Research by Klein and Salzman of the University of Rochester. The findings were described as being of a preliminary nature and were derived from a sample of 39 children of whom 10 were at high risk having mothers with a consensus diagnosis of schizophrenia. Klein and Salzman used a modified version of an auditory stimulus tape used by Mednick, Schulsinger and Venables in the most recent high risk study in Copenhagen - of which the Mauritius tape is a shortened version. The results are described as follows:

"No differences were found between high and low risk offspring either in terms of trials to habituation response amplitude or latency or spontaneous responses. Electrodermal measures collected during the conditioning experiment indicated that sensitization to the CS did occur and there was some evidence of differential conditioning in the two groups of children. High risk offspring produced significantly larger skin conductance responses to interpolated unreinforced trials than did low risk offspring. High risk Ss were also significantly more responsive to the UCS than low risk Ss ... low risk

offspring manifested higher levels of tonic conductance than did high risk offspring during conditioning but not during resting or habituation and higher levels of heart rate throughout all procedures."

This list of results can, at least in part, be tested in the present context and are now presented as a series of statements:

1. "-high risk offspring produced significantly larger responses to interpolated unreinforced trials".

In the present experiment such trials are those to stimuli 10, 13, 18, 19, 20, 22, 23, 24.

The data presented in Table 7 show that the present results are at a highly significant level, in accord with Klein and Salzman and it should be added also with that presented by Mednick and Schulsinger (1968) in Figure 2, page 284, where they show a higher amplitude of conditioned responses to non-reinforced trials. It should, of course, be noted in the present context that responses 18C, 19C and 20C were used in selection of the risk groups.

2. "-high risk Ss were also significantly more responsive to the UCS than low risk Ss".

In the present experiment the relevant responses are 7C, 8C, 11C, 12C, 15C and 17C. Data presented in Table 8 show again confirmation of Klein and Salzman's results. It is perhaps interesting to note the large response by group S1 to stimulus 15. This occurs just after a trial with a CS- stimulus and consequently it could be suggested that the high risk group is particularly (and abnormally) alerted by the change in stimulus configuration.

Again it should be noted that these results are in accord with those of Mednick and Schulsinger (1968) Table 5, page 283.

3. "-low risk offspring manifested higher levels of tonic conductance than did high risk offspring during conditioning but not during resting or habituation."

Data in Table 9 show that the present data are not in accord with the Klein and Salzman findings as they show a substantially higher skin conductance level throughout in the hyper-responsive high risk groups than the control group. In the original Mednick and Schulsinger study there was no difference between groups on tonic electrodermal levels.

4. "-no differences were found between high and low risk offspring in terms of ... latency".

Table 10 presents the data for the present study which does not permit such a straight forward statement to be made. Generalizations that are possible are that differences appear between groups when orientation is taking place, that is, particularly in Trial 1 when a stimulus is presented for the first time, in Trial 4 when a new stimulus is presented and to the conditioned stimuli which as signal stimuli always have an orienting function. Again differences in responses are shown when examining responses to the omitted UCS after the positive conditioned stimulus. In other words, the subject is expecting a stimulus which does not arrive.

In the case of the response to the UCS there are no differences in latency, largely it would appear because of the lengthening of latency of response of the S2 and C groups. There are also no differences

in latency to the omitted UCS after CS- and this appears to be due to the shortening of latency of the high risk groups.

The data do not therefore confirm the Klein and Salzman material nor are they in accord with those presented by Mednick (1967) where he showed (page 192, Table II) that the latency of most responses was faster in the high risk than in the low risk subjects. However, recent work on orientation responses in schizophrenia patients carried out in York (Patterson and Vanables, in preparation) shows that there is a tendency for schizophrenic patients to have longer latency responses to orienting stimuli than matched normals.

5. "-no differences were found between high risk and low risk offspring in terms of ... spontaneous responses."

In the present data the S group (S1 and S2 combined) showed 4.6 SD 2.7 responses and the C group 3.0 SD 2.5 responses in an initial half minute rest period, with the large N in this study the difference was significant; the same difference would not, however, be significant with the numbers in Klein and Salzman's study. If their sample included some non-responders then it is possible that this might explain the lack of difference in spontaneous responding in their study. The present data do not therefore seem to be in disagreement with Klein and Salzman.

6. "-low risk offspring manifested higher levels of heart rate throughout all procedures".

In the present study S group subjects had a mean initial heart rate of 124.14 bpm and the C group a mean heart rate of 124.99 bpm. This

difference was not significant. Other heart rate measures are not available at this time.

Data from Copenhagen (Herman, 1972) is in accord with the present findings in showing that high and low risk groups did not differ on heart rate measured at the start of the experiment.

An unusual finding in the present experiment is that the non-responder group had an initial level of 135.2 beats per minute which was significantly higher than the S or the C groups.

In summarizing, there are some areas of substantial convergence between the Klein/Salzman, Mednick/Schulsinger studies and the present one, these being very largely in the area of phasic responses. Where there is less agreement is in tonic levels of activity. As there is virtually no psychophysiological data of a developmental kind which would enable a limit to be made between the present 3 year old children and the older children of the other studies, it is not possible to establish whether the disagreements in this tonic data are due to age differences.

Overall, however the present data do not give any reason to think that they contain inconsistencies. The latency data have already been described which indicate that they fit reasonably with predictions. Recovery data also accord with expectations. Early in the orientation series recovery times are very short, and shorter, of course, in the S groups. The responses to the UCS all have significantly longer recovery times as would be expected following Edelberg's (1970) data where responses to aversive or unpleasant stimuli have early recovery times. In spite of the general lengthening of recovery to these stimuli, those

of the S groups are still shorter than those of the C group. Thus, if the point of view of Venables (1974) that shortness of SCR recovery is an indication of "openness to the environment" is taken, then what is in general being indicated is that those children who are in the S group are abnormally "open" and as this is the case with the more aversive stimuli they are possibly on this account more vulnerable. This point will be taken up in the final discussion after the next and most important of the interim validation data have been presented.

## Validation of selection by assessment of behaviour

One of the basic tenets of 'high risk' work is that although indications of the later breakdown are sought in a population that is well at the time of testing, there is necessarily some difference in behaviour between those who will remain well and those who will succumb. Clearly, if this were not so then the point of the research would be lost. Nevertheless, herein lies the paradox of this work, for if the early behaviour of those who were to succumb were to be considered abnormal then it is unlikely that they would be considered as classic schizophrenics where by tradition schizophrenia is a disease with its onset in early adulthood. The attractiveness of the use of psychophysiological indices as possible indications of later breakdown is because they are 'covert' and not available to public inspection. They are not, because of this, in general to be considered part of the subject's relation with his social environment and hence perhaps more 'culture free' than other measurable indices.

Other overt behaviour, however, may be assumed to distinguish high risk and low risk groups and has indeed been shown to do so (see reviews by Garmezy, 1974); it is, however, to be expected that the distinguishing behaviour will fall within normal limits and will not be viewed as unusual by peers or seniors.

Thus, if the division of the children in this study into high and low risk groups on the basis of some of their measured psychophysiological indices in 1972/73 has been successful in a wider sense than producing groups whose overall psychophysiological status is different, it is to be supposed that differences in their overt behaviour might be seen at a later stage. In other words, while the study of the data presented earlier in this paper has shown it to be reasonably internally consistent, and in general accord with the findings of other studies, a further converging operation is necessary to show that successful selection has actually taken place.

The children in this study undertook the original psychophysiological selection procedure in 1972/73 when they were aged 3. In December 1976 when most of these children were aged 6 they entered the primary school system. The opportunity was taken just before they made this transition to examine their behaviour in a standard play situation.

Parents of both the 'nursery schools' and 'community' samples of selected children were informed of the intention of carrying out an assessment of their children. A social worker visited them and gave them an opportunity of discussing the details of the study and making practical arrangements. Parental co-operation was obtained in 93% of the families.

Children were invited to attend the project's Research Centre - which

was in a different house from either of the nursery schools - in groups of four; one child from each of the nursery schools and one from each of the corresponding community groups. The children were provided with new identical uniforms to come to the Research Centre, and were thus as far as possible unidentifiable as to group origin. Three groups of four children visited the Centre each day.

The children's behaviour was rated in accordance with a scale adapted from that designed by Bell et al (1971). Two workers who had not met the children on previous occasions, and who had been trained in the rating technique acted as observers. The children were observed in indoor play; equipment and toys were provided and particular care was taken not to introduce items which were very familiar to the children. All items were new and five of the seven sets of equipment had not been used in the pre-school units before.

Thus steps were taken to eliminate as far as possible any bias towards identification of better performance by the nursery school children (a) by the use of similar clothing for all children, (b) by the use of observers who did not know the children, and (c) by the use of generally unfamiliar equipment and toys. Video tapes of the children's behaviour were also made and may be used at a later stage to independently validate the observations reported.

The children waited in a playground with swings, see-saw and a sand pit before being called into the observation play room. The behaviour in the playground was not rated and was used solely as an opportunity for the children to mix socially.

The group of four children together was called into the observation room

in which they found play areas with toys and equipment laid out. Each child's behaviour was rated over an eight minute period. The rating system used employs counts of behaviour, such as number of times a child played with a particular toy, changed toys, approached adults, etc., and also timings of aspects of behaviour.

It is the data from these timed aspects of behaviour that are to be reported here; these are

(a) 'Constructive play alone' - a category that was recorded when a child played constructively with a toy or toys by himself.

(b) 'Positive interaction' - included in this category was talking, co-operative play, helping or accepting help from a peer.

(c) "Watching' - this category was timed when a child watched a peer or adult while not otherwise interacting.

It should be noted that the categories of activity are mutually exclusive and thus the times spent on each out of eight minutes are not independent.

The data were analysed using analyses of variance with 'group', i.e. school or community, and 'risk', i.e. the risk categories, S, short recovery, N, non responder, L, long recovery and C, control, as the factors. Previous analyses had shown that the factor 'district', i.e. Vacaos or Quatre Bornes was not a significant variable, bearing in mind, however, that there are no L category children in the Vacaos District sample.

The data are presented in Figures 3 and 4.

On these figures are presented the p values associated with the factors and their interaction.

In the case of 'constructive play alone' (Figure 3) the interaction between risk and group is significant and this is due to the large effect of exposure to the school experience in the C control group as against the non-significant effect of that experience in the three risk groups.

In the case of 'positive interaction', which it will be remembered is basically social interaction, there is again a significant groups x risk interaction term, the noteworthy finding being the extreme amount of positive interaction in the L group exposed to school experience. The low levels of positive interaction in the school control group is due to the majority of their time being spent in constructive play.

The variable of 'watching' shows significant effects of the two main groups, while the group x risk interaction does not quite reach significance. The main finding is thus that school experience has an overall effect of lessening the amount of watching, which might be seen as a somewhat pathological variable having neither the positive aspects of constructive play nor interaction. Although the interaction term is not significant it can be seen that the effect of school experience on the non-responders is absent and the beneficial effect on this high risk groups appears to be non-existent.

The questions to be asked of these data are, do they accord with expectation and do they violate the sorts of notions put forward about the pre-morbid state of those who might later succumb to psychiatric disorders? Also it can be asked, has the school experience been

beneficial and hence might it be used as the basis for a preventive program with children at risk?

In the case of the control group the effect of the nursery school as against the non-school experience is fairly to be seen as in accord with expectations. The school children spend a considerable amount of their time in constructive play and markedly reduce the time spent in 'just watching' others. For the control group the school experience is obviously beneficial.

In the case of the S, short recovery, hyper-responsive group, who it will be remembered are most like those in Copenhagen who later succumb with first rank symptoms of schizophrenia, perhaps the most interesting feature is that, with or without school experience, they have a high level of 'constructive play'. This level it should be noted is higher than that of the control group without school experience. The significance of this finding will be discussed later. The other data on this group shows an apparent beneficial effect of school experience in that watching is reduced and positive interaction increased. Overall, the School experience appears to be beneficial to the high risk group in that it provides a setting in which their already high levels of constructive play may be effectively channeled by the fact that they show in school an increased level of social interaction.

The most pessimistic results are, however, found in the case of the non-responder group. These are the subjects whose psychophysiological responses are akin to those adult schizophrenics who are rated as low on florid symptoms and could possibly, although not universally, be thought of as exhibiting 'defect' states. Their presence does not appear to have been recorded in other high risk studies; this is

possibly because they represent the schizophrenic of the 'process' kind who is typified by low levels of pre-morbid sexual activity, by low rates of marriage, and hence by low levels of fertility, consequently being underrepresented in genetic risk studies.

In the play situation these children show high levels of watching, unmodified by school experience, low levels of constructive play, again unmodified by school experience and only a moderate increase in interaction due to that experience.

Although, because the numbers are few, not too great weight can be placed on the results, the findings with the L, long recovery, group are of interest. These are the children whose psychophysiological responses suggested psychopathic or criminal tendencies. In them, the exposure to school has had the effect of greatly increasing positive interaction to a higher level than that shown by any other children and this effect is achieved by spending less time playing constructively than any other children along with a corresponding fall in time spent 'watching'. The school experience has thus provided the possibility for these children to interact with others, perhaps to the exclusion of other behaviour. It clearly depends on society's view of what is important for a school to achieve if this effect is to be seen as of benefit or not.

In summary, the results of this study are two-fold; firstly, it appears to be possible to select, by psychophysiological techniques at the age of 3, children who behave differently at the age of 6 and who react differently to the intervening experience of attendance at a nursery school. Furthermore, the type of behaviour exhibited by the children is not in discord with what might legitimately be expected on the basis

of earlier high risk studies and data from work on adult patients.

The potentially most interesting finding is that of the high level of 'constructive play' exhibited by both school and community samples of S, short recovery high risk children.

It has been suggested (Venables, 1974) that the short recovery limb of the skin conductance response is exhibited by subjects whose characteristic mode of attention deployment is one of "openness to the environment". This suggestion has been supported by data from work on animals. Bagshaw and Kimble (1972) showed that hippocampectomized monkeys exhibit the sort of skin conductance response described in the present study as characterizing the S high risk group, and work by Douglas (1967) suggests that one of the functions of the hippocampus is that of sensory response gating: the hippocampectomized animals or the subject with an imbalance of function of the hippocampus in the direction of underactivity is to be expected to show both poor sensory input filtering and short recovery SCR responding. Recent work by Lobstein (personal communication) has shown the short recovery SCR is significantly correlated with deceleration of the phasic HR responses. This latter type of responsivity is that described by Lacey (e.g. 1967) as indicative of the stance of "openness to the environment".

The association between creativity and schizophrenia has been suggested on several occasions, e.g. McConaghy and Clancey (1968) and Claridge (1972). Dellas and Gaier (1970) have suggested that "creative persons ... deployed their attention more widely, were more aware of and receptive and retained more stimulus experience in unstable form, tending not to screen out the irrelevant".

It thus seems possible that the constructive play shown by the S high risk group in the present study might be considered as an example of the creativity shown by those tending not to extensively filter their stimulus input.

Lehman (1966) states in considering the similarity between schizophrenic and creative subjects - "if he is capable of coping with this greater than average influx of discrete sensory stimuli he might perform at a better than average level; but when the extraordinary sensitivity of his receptive apparatus is not matched by an equally extraordinary performance of his central processing apparatus then his integration breaks down and he may become psychotic". Dykes and McGhie (1976) in following up these views in an experiment on schizophrenic and creative subjects suggest that the voluntary control over attentional strategies is what distinguishes schizophrenic from creative subjects.

It may be that the most important aspect of the study so far is that of the challenge of being able to teach the S group type of child to gain voluntary control over the deployment of his attention and thus exploit potential creativity rather than allow it to descend to the waste of schizophrenia.

Table 1

Characteristics of the total sample of 3 year olds.

| Race | Male | Female | Total N | % | | |
|---|---|---|---|---|---|---|
| Hindu | 365 | 337 | 702 | 39.0 | 49.0 | (50.0)* |
| Tamil | 96 | 84 | 180 | 10.0 | | |
| Moslem | 175 | 180 | 355 | 19.7 | | (16.0)* |
| General Population† | 239 | 224 | 463 | 25.7 | | (29.0)* |
| Chinese | 16 | 16 | 32 | 1.8 | | (4.0)* |
| Other | 34 | 34 | 68 | 3.8 | | |
| Total | 925 (51.4%) | 875 (48.6%) | | | | |

† General population is the official description for that part of the population sometimes called Creole. It is likely that those designated as 'other' in our sample should be included with the general population.

* Figures in parentheses are the official percentage figures obtained from the latest census data.

Table 2

| | Taped Stimuli | | Responses used in selection | | |
|---|---|---|---|---|---|
| | S1 | S2 | A | B | C |
| 1 | OS1 | - | X | | |
| 2 | OS1 | - | | | |
| 3 | OS1 | - | | | |
| 4 | OS2 | - | | | |
| 5 | OS2 | - | | | |
| 6 | OS2 | - | | | |
| 7 | CS1 | UCS | | | X |
| 8 | CS1 | UCS | X | | |
| 9 | CS2 | - | | | |
| 10 | CS1 | - | | | |
| 11 | CS1 | UCS | | | |
| 12 | CS1 | UCS | | | |
| 13 | CS1 | - | | | |
| 14 | CS2 | - | | | |
| 15 | CS1 | UCS | | | |
| 16 | CS2 | - | | | |
| 17 | CS1 | UCS | | | |
| 18 | CS1 | - | X | X | X |
| 19 | CS1 | - | X | X | X |
| 20 | CS1 | - | X | X | X |
| 21 | CS2 | - | | | |
| 22 | CS1 | - | | | |
| 23 | CS1 | - | | | |
| 24 | CS1 | - | | | |

Table 3

Characteristics of sample of 200 children allocated to nursery schools and matched "community" sample.

| | Sex | | Total | % | | |
|---|---|---|---|---|---|---|
| | Male | Female | | | | |
| Hindu | 40 | 37 | 77 | 38.5 | 46.5 | (49.0)* |
| Tamil | 6 | 10 | 16 | 8.0 | | |
| Moslem | 17 | 26 | 43 | 21.5 | | (19.7)* |
| General Population | 36 | 28 | 64 | 32.0 | | (25.7)* |
| Chinese | | | 0 | 0 | | (1.8)* |
| Other | | | 0 | 0 | | (3.8)* |
| Total | 99 | 101 | | | | |

* Figures in parentheses are the percentage figures found in the total sample of 1800 children. (See Table 1.)

Table 4

Number of subjects allocated to psychophysiologically defined risk and control groups out of a total of 1800 subjects tested.

| | N | % |
|---|---|---|
| Non-responders (N) | 45 | 2.5 |
| Subjects with large amplitude short recovery SCRS (Hyper-responders) (S) | 141 | 7.8 |
| Subjects with medium amplitudes very long recovery SCRs (L) | 101 | 5.6 |
| Subjects with medium amplitudes medium recovery SCRs (Controls) (C) | 214 | 11.9 |
| Unallocated | 1299 | 72.2 |

Table 5

Numbers of subjects allocated to psychophysiologically defined risk and control groups in nursery schools and community groups.

| | Groups | | | | |
|---|---|---|---|---|---|
| | N | S | L | C | Total |
| Vacaos School | 10 | 26 | 0 | 14 | 50 |
| Vacaos Community | 14 | 27 | 0 | 9 | 50 |
| Quatre Bornes School | 7 | 23 | 5 | 15 | 50 |
| Quatre Bornes Community | 6 | 23 | 6 | 15 | 50 |
| Totals | 37 | 99 | 11 | 53 | 200 |

Table 6

Results of discriminant analysis predicting group membership from variables unused in original selection.

| Actual Group | No* | Predicted group membership | | | |
|---|---|---|---|---|---|
| | | S | N | C | L |
| S | 141 | 103 (73)† | 0 | 22 (15.6) | 16 (11.3) |
| N | 45 | 0 | 44 (97.8) | 1 (2.2) | 0 |
| C | 120 | 11 (9.2) | 1 (0.8) | 81 (67.5) | 27 (22.5) |
| L | 101 | 2 (2.0) | 0 | 31 (30.7) | 68 (67.3) |
| Ungrouped | 1388 | 87 (6.3) | 178 (12.8) | 504 (36.3) | 619 (44.6) |

Percentage of cases correctly classified 72.3

* These numbers do not accord with those in Table 4 as the allocation to C group was narrowed to eliminate Ss showing <u>any</u> high risk type response patterns.

† Row percentages in brackets.

Table 7

Response amplitudes (Micromhos/cm$^2$) on non-reinforced trials defined as C responses by occurring in the latency window 1 to 3 seconds after UCS onset. Data from two high risk S groups (S1 having nine or more and S2 six or more criterion responses) and the control C group.

| Response | S1 | S2 | C | p |
|---|---|---|---|---|
| 10C | .16 | .11 | .06 | < .001 |
| 13C | .16 | .09 | .04 | < .02 |
| 18C* | .19 | .14 | .04 | < .001 |
| 19C* | .16 | .12 | .04 | < .001 |
| 20C* | .18 | .09 | .04 | < .001 |
| 22C | .11 | .10 | .03 | < .001 |
| 23C | .08 | .10 | .04 | < .03 |
| 24C | .14 | .07 | .04 | < .001 |

* Used in selection of the risk groups

Table 8

Response amplitudes (micromhos/cm$^2$) to the UCS on reinforced trials. Data for two high risk groups S1 and S2 and the control group C as in Table 7.

| Response | Group | | | p |
|---|---|---|---|---|
| | S1 | S2 | C | |
| 7C* | .43 | .49 | .26 | < .001 |
| 8C | .39 | .40 | .20 | < .001 |
| 11C | .30 | .33 | .18 | < .001 |
| 12C | .28 | .28 | .15 | < .001 |
| 15C | .41 | .32 | .14 | < .001 |
| 17C | .32 | .29 | .13 | < .001 |

* Used in selection of risk group

Table 9

Levels of skin conductance (micromhos/cm$^2$) during orientation, conditioning and extinction in two short-recovery (hyper-responsive) high risk groups, S1 and S2, and the control group, C.

| | S1 | S2 | C | p |
|---|---|---|---|---|
| Orientation | 4.6 | 3.7 | 2.4 | < .001 |
| Conditioning | 5.1 | 4.1 | 2.8 | < .001 |
| Extinction | 5.1 | 3.9 | 2.7 | < .001 |

Table 10

Latencies of responses (secs) to orienting stimuli 1–6, to positive conditioned stimuli CS+, to negative conditioned stimuli CS–, to the UCS on reinforced trials, to the omitted UCS after CS+, to the omitted UCS after CS–, in two high risk groups, S1 and S2, and the control group, C.

| | | | | | |
|---|---|---|---|---|---|
| A. To orienting stimuli | 1 | 1.70 | 1.52 | 1.22 | < .04 |
| | 2 | 1.32 | 1.26 | 1.26 | NS |
| | 3 | 1.74 | 1.51 | 1.30 | < .10 |
| | 4 | 2.33 | 1.25 | 1.27 | < .002 |
| | 5 | 1.35 | 1.24 | 1.20 | NS |
| | 6 | 1.98 | 1.32 | 1.40 | < .008 |
| B. To CS+ (A resp) | | 1.52 | 1.30 | 1.12 | < .001 |
| C. To CS– (A resp) | | 1.43 | 1.29 | 1.08 | < .001 |
| D. To UCS on reinforced trials (C resp) | | 1.41 | 1.40 | 1.31 | NS |
| E. To omitted UCS after CS+ during conditioning (C resp) | | 2.08 | 1.53 | 1,23 | < .001 |
| F. To omitted UCS after CS+ after conditioning (C resp) | | 1.34 | 1.34 | 1.02 | < .001 |
| G. To omitted UCS after CS– (C resp) | | 1.16 | 1.14 | 1.04 | NS |

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Figure 1

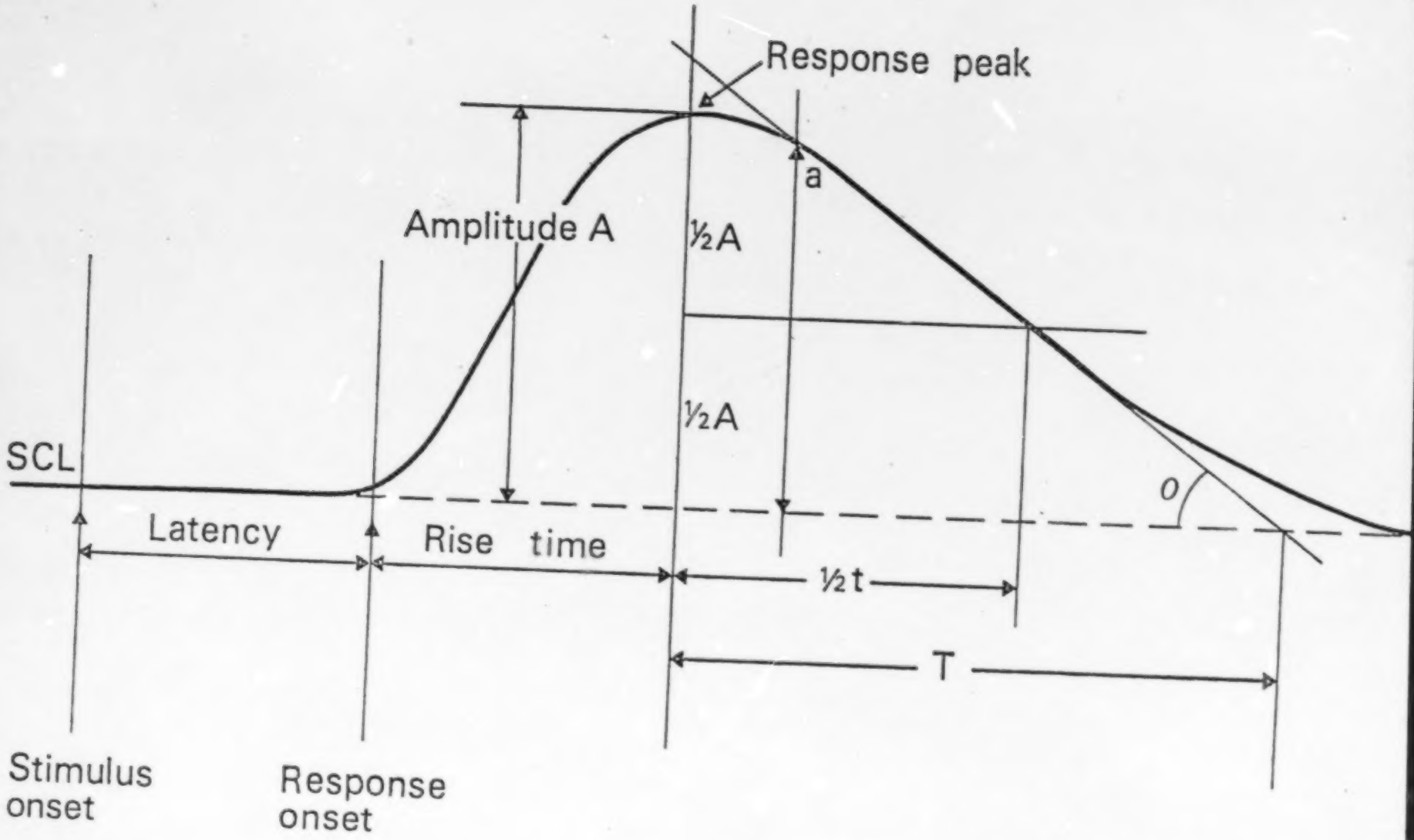
Response peak
a
Amplitude A
½A
½A
SCL
Latency
Rise time
½t
T
Stimulus onset
Response onset

Figure 2

Timing of stimuli on auditory tape and definition of responses by latency 'window' cr

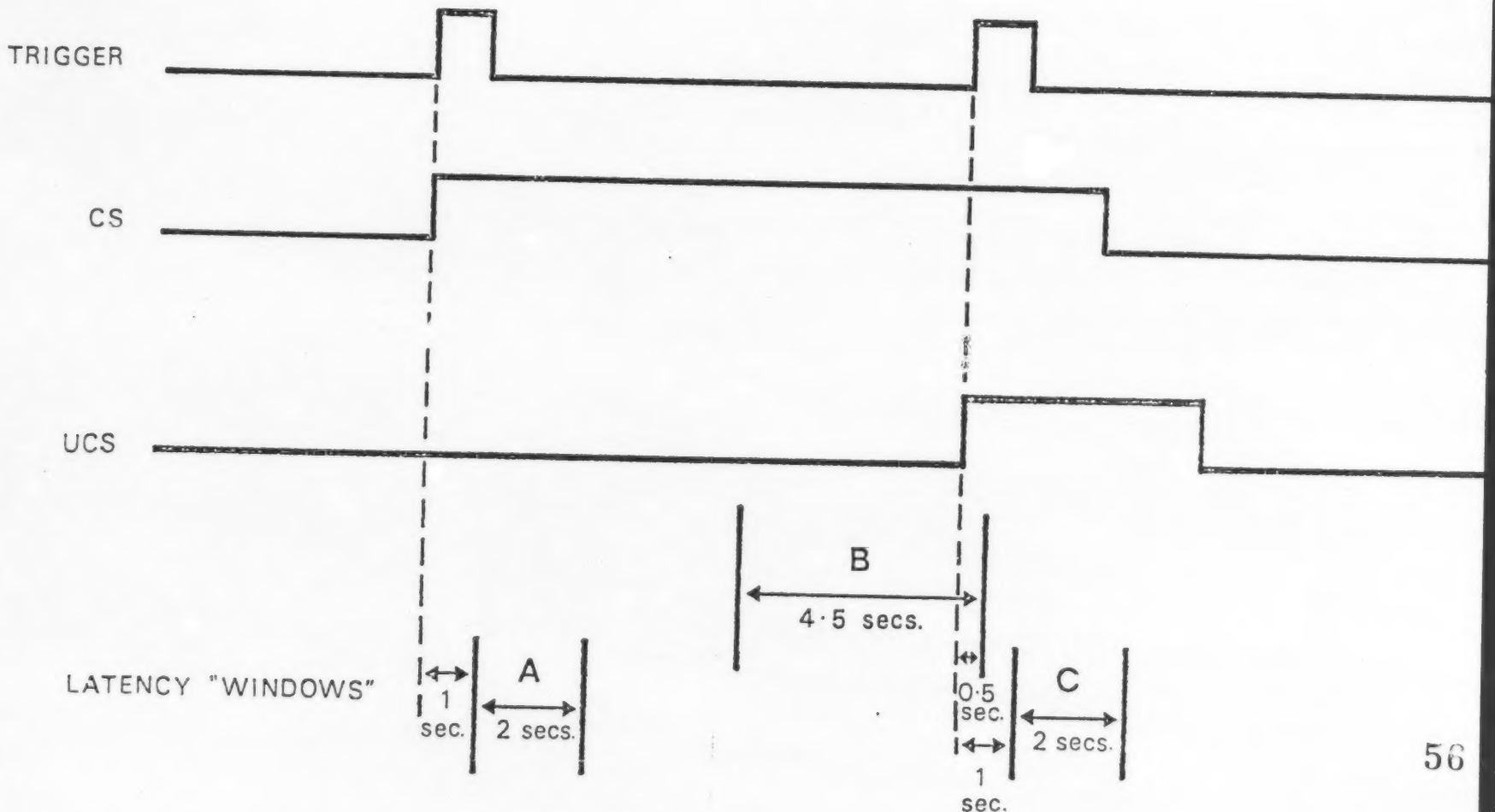

Figure 3

Time spent in 'constructive play' by four psychophysiologically defined groups

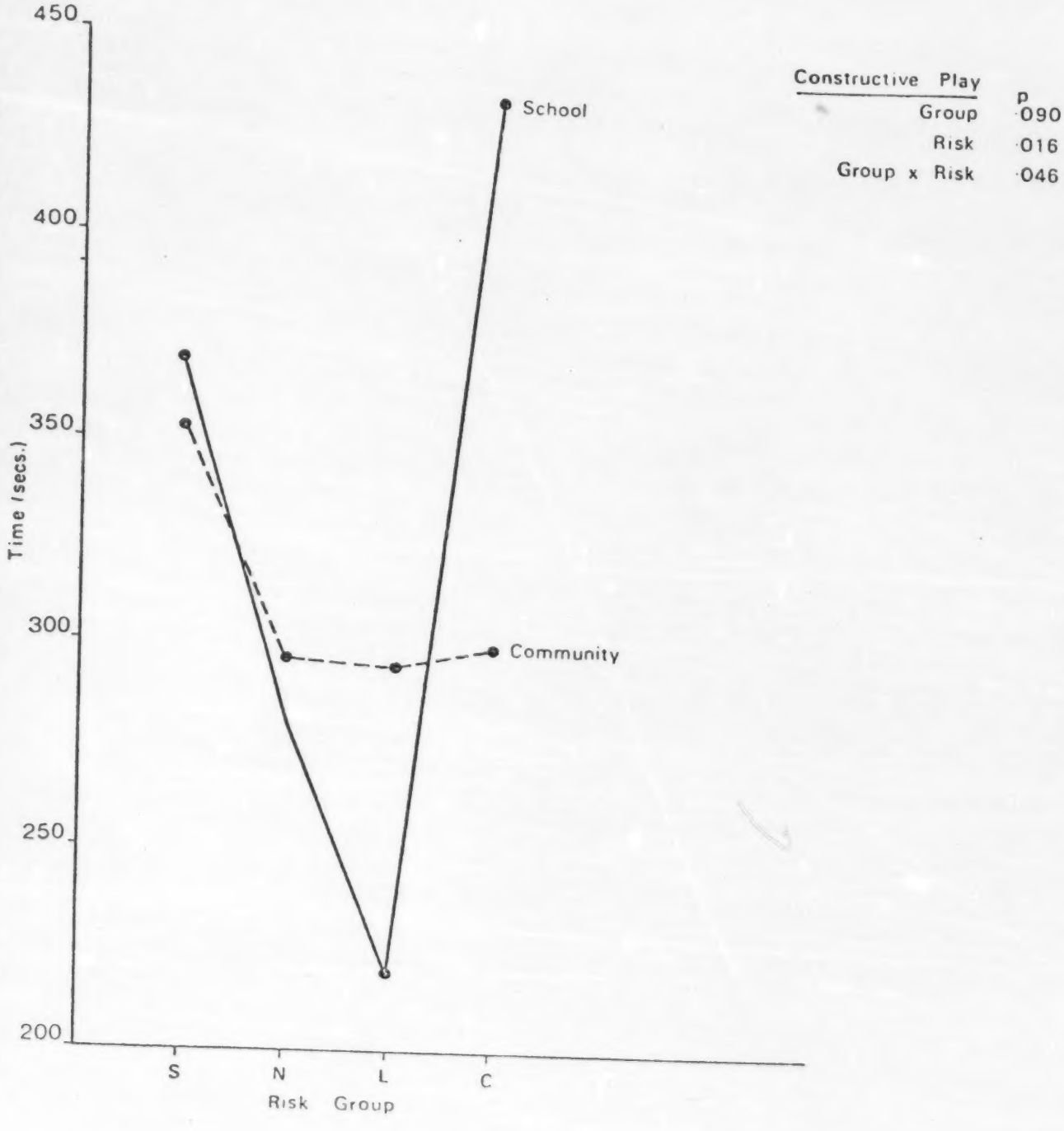

Figure 4a

Time spent in 'watching' by four psychophysiologically defined groups

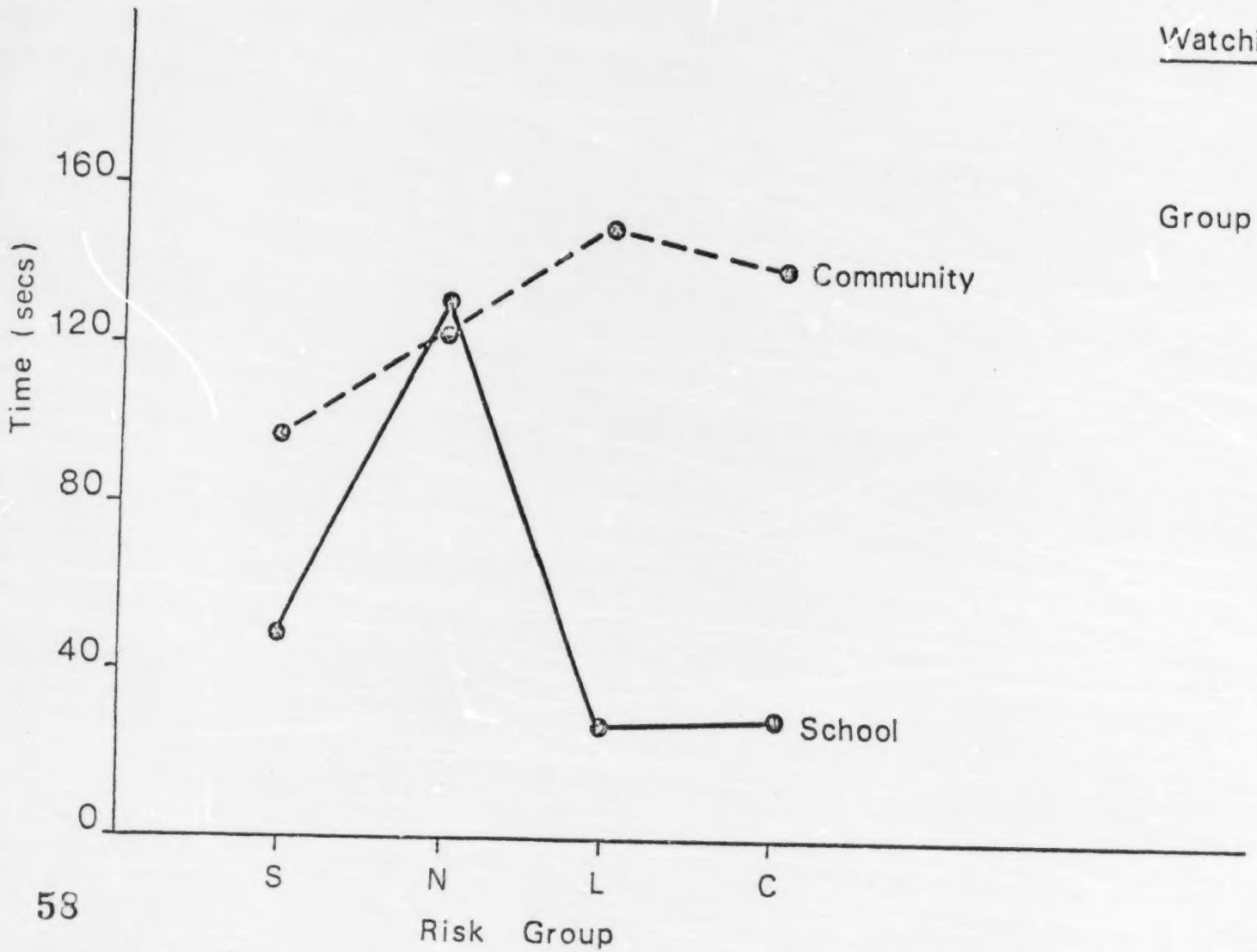

Figure 4b

Time spent in 'positive interaction' by four psychophysiologically defined groups